

WHAT IS CLAIMED IS:

1. A method for producing a magnetoresistive element comprising a tunnel insulating layer, and a first magnetic layer and a second magnetic layer that are laminated so as to sandwich the tunnel insulating layer,
5 wherein a resistance value varies depending on a relative angle between magnetization directions of the first magnetic layer and the second magnetic layer, the method comprising the steps of:
 - (i) laminating a first magnetic layer, a third magnetic layer and an Al layer successively on a substrate;
 - (ii) forming a tunnel insulating layer containing at least one compound selected from the group consisting of an oxide, nitride and oxynitride of Al by performing at least one reaction selected from the group consisting of oxidation, nitriding and oxynitriding of the Al layer; and
 - 15 (iii) forming a laminate comprising the first magnetic layer, the tunnel insulating layer and a second magnetic layer by laminating the second magnetic layer in such a manner that the tunnel insulating layer is sandwiched by the first magnetic layer and the second magnetic layer,
wherein the third magnetic layer has at least one crystal structure
20 selected from the group consisting of a face-centered cubic crystal structure and a face-centered tetragonal crystal structure and is (111) oriented parallel to a film plane of the third magnetic layer.
2. The method for producing a magnetoresistive element according to
25 claim 1,
wherein the third magnetic layer comprises a magnetic material containing at least one element selected from the group consisting of Fe, Co and Ni.
- 30 3. The method for producing a magnetoresistive element according to claim 2,
wherein the magnetic material has a composition represented by the formula Fe_xCo_y ,
where x and y are values satisfying the following equations:
35 $x + y = 1$
 $0.05 \leq x \leq 0.3$
 $0.7 \leq y \leq 0.95$

4. The method for producing a magnetoresistive element according to claim 2,
 wherein the magnetic material has a composition represented by the
 5 formula $\text{Fe}_{x'}\text{Ni}_{y'}$,
 where x' and y' are values satisfying the following equations:
 $x' + y' = 1$
 $0 \leq x' \leq 0.7$
 $0.3 \leq y' \leq 1$.
- 10 5. The method for producing a magnetoresistive element according to claim 2,
 wherein the magnetic material further contains at least one element selected from the group consisting of Rh, Pd, Ag, Ir, Pt and Au.
- 15 6. The method for producing a magnetoresistive element according to claim 5,
 wherein the magnetic material has a composition represented by the formula M_pZ_q ,
 20 where M is at least one element selected from the group consisting of Fe, Co and Ni,
 Z is at least one element selected from the group consisting of Rh, Pd, Ag, Ir, Pt and Au, and
 p and q are values satisfying the following equations:
 25 $p + q = 1$
 $0.6 \leq p \leq 0.99$
 $0.01 \leq q \leq 0.4$.
- 30 7. The method for producing a magnetoresistive element according to claim 1,
 wherein an antiferromagnetic layer is laminated between the substrate and the first magnetic layer in the step (i).
- 35 8. The method for producing a magnetoresistive element according to claim 1, further comprising the step of:
 (a) heat treating the laminate, after the step (iii).

9. A magnetoresistive element comprising: a tunnel insulating layer containing at least one compound selected from the group consisting of an oxide, nitride and oxynitride of Al; a first magnetic layer and a second magnetic layer that are laminated so as to sandwich the tunnel insulating layer; and a third magnetic layer disposed between the first magnetic layer and the tunnel insulating layer,

wherein a resistance value varies depending on a relative angle between magnetization directions of the first magnetic layer and the second magnetic layer, and

the third magnetic layer has at least one crystal structure selected from the group consisting of a face-centered cubic crystal structure and a face-centered tetragonal crystal structure and is (111) oriented parallel to a film plane of the third magnetic layer.

10. The magnetoresistive element according to claim 9,
wherein the third magnetic layer comprises a magnetic material containing at least one element selected from the group consisting of Fe, Co and Ni.

11. The magnetoresistive element according to claim 10,
wherein the magnetic material has a composition represented by the formula Fe_xCo_y ,

where x and y are values satisfying the following equations:

$$x + y = 1$$

$$0.05 \leq x \leq 0.3$$

$$0.7 \leq y \leq 0.95$$

12. The magnetoresistive element according to claim 10,
wherein the magnetic material has a composition represented by the formula $\text{Fe}_{x'}\text{Ni}_{y'}$,

where x' and y' are values satisfying the following equations:

$$x' + y' = 1$$

$$0 \leq x' \leq 0.7$$

$$0.3 \leq y' \leq 1$$

13. The magnetoresistive element according to claim 10,
wherein the magnetic material further contains at least one element

selected from the group consisting of Rh, Pd, Ag, Ir, Pt and Au.

14. The magnetoresistive element according to claim 13,
wherein the magnetic material has a composition represented by the
5 formula M_pZ_q ,
where M is at least one element selected from the group consisting of
Fe, Co and Ni,
Z is at least one element selected from the group consisting of Rh, Pd,
Ag, Ir, Pt and Au, and
10 p and q are values satisfying the following equations:
 $p + q = 1$
 $0.6 \leq p \leq 0.99$
 $0.01 \leq q \leq 0.4$

15. The magnetoresistive element according to claim 9, further
comprising an antiferromagnetic layer.

16. The magnetoresistive element according to claim 15,
wherein the antiferromagnetic layer is disposed on a side opposite a
20 plane of the first magnetic layer facing the tunnel insulating layer and is
(111) oriented parallel to a film plane of the antiferromagnetic layer.

17. A magnetic head comprising the magnetoresistive element according
to claim 9 and a shield for limiting an introduction of a magnetic field other
25 than a magnetic field to be detected by the magnetoresistive element to the
magnetoresistive element.

18. A magnetic head comprising the magnetoresistive element according
to claim 9 and a magnetic flux guiding portion for guiding a magnetic field
30 to be detected by the magnetoresistive element to the magnetoresistive
element.

19. A magnetic memory comprising the magnetoresistive element
according to claim 9, an information recording conductive line for recording
35 information on the magnetoresistive element and an information reading
conductive line for reading the information.

20. The magnetic memory according to claim 19,
wherein a plurality of the magnetoresistive elements are disposed in
the form of a matrix.
- 5 21. A magnetic recording device comprising the magnetic head according
to claim 17 and a magnetic recording medium capable of reading magnetic
information with the magnetic head.
- 10 22. A magnetic recording device comprising the magnetic head according
to claim 18 and a magnetic recording medium capable of reading magnetic
information with the magnetic head.